World Academy of Science, Engineering and Technology
International Journal of Chemical and Materials Engineering
Vol:12, No:02, 2018

Study of Motion of Impurity Ions in Poly(Vinylidene Fluoride) from View Point of Microstructure of Polymer Solid

Authors : Yuichi Anada

Abstract : Electrical properties of polymer solid is characterized by dielectric relaxation phenomenon. Complex permittivity shows a high dependence on frequency of external stimulation in the broad frequency range from 0.1mHz to 10GHz. The complex-permittivity dispersion gives us a lot of useful information about the molecular motion of polymers and the structure of polymer aggregates. However, the large dispersion of permittivity at low frequencies due to DC conduction of impurity ions often covers the dielectric relaxation in polymer solid. In experimental investigation, many researchers have tried to remove the DC conduction experimentally or analytically for a long time. On the other hand, our laboratory chose another way of research for this problem from the point of view of a reversal in thinking. The way of our research is to use the impurity ions in the DC conduction as a probe to detect the motion of polymer molecules and to investigate the structure of polymer aggregates. In addition to the complex permittivity, the electric modulus and the conductivity relaxation time are strong tools for investigating the ionic motion in DC conduction. In a non-crystalline part of melt-crystallized polymers, free spaces with inhomogeneous size exist between crystallites. As the impurity ions exist in the non-crystalline part and move through these inhomogeneous free spaces, the motion of ions reflects the microstructure of non-crystalline part. The ionic motion of impurity ions in poly(vinylidene fluoride) (PVDF) is investigated in this study. Frequency dependence of the loss permittivity of PVDF shows a characteristic of the direct current (DC) conduction below 1 kHz of frequency at 435 K. The electric modulus-frequency curve shows a characteristic of the dispersion with the single conductivity relaxation time. Namely, it is the Debye-type dispersion. The conductivity relaxation time analyzed from this curve is 0.00003 s at 435 K. From the plot of conductivity relaxation time of PVDF together with the other polymers against permittivity, it was found that there are two group of polymers; one of the group is characterized by small conductivity relaxation time and large permittivity, and another is characterized by large conductivity relaxation time and small permittivity.

Keywords : conductivity relaxation time, electric modulus, ionic motion, permittivity, poly(vinylidene fluoride), DC conduction
Conference Title : ICP 2018 : International Conference on Polymer
Conference Location : Paris, France
Conference Dates : February 19-20, 2018